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Spectral Quality and Stability of Infrared Free Electron Lasers Driven by RF Linacs* Ming Xie, Kwang-Je Kim, Lawrence Berkeley Laboratory, Berkeley, CA 94720, Steve Benson, Department of Physics, Duke University, Durham, NC 27706. ---- There has been a growing user interest in free electron lasers (FELs) driven by rf linacs as a source of tunable, intense and coherent radiation in the infrared (IR) region. The basic operation of IRFELs is well-understood through the pioneering work at Stanford University and Los Alamos National Laboratory. However, FELs for a dedicated user facility will need to satisfy much more stringent requirements in the output characteristics than have been previously discussed. Important among these are greater degrees of spectral purity, stability in wavelength and intensity, and higher pulse energy. In this paper, we discuss the implication of these requirements on design of accelerators and FELs. For example, for FELs driven by rf linacs, the slippage effect is important because of the unique pulse structure of the electron beam. As a result, the length of the optical cavity becomes a crucial parameter. Thus we show by simulation that the cavity length can be adjusted (detuned) to control various FEL characteristics such as gain, efficiency, temporal pulse shape, spectral purity, etc. We also study the sensitivity of FEL wavelength and intensity to fluctuations in electron energy and timing. We find that fluctuation in the FEL parameters depends on the amplitude as well as on the frequency of electron beam fluctuation. Based on user requirements for FEL stability, our study leads to a set of tolerance requirements for the electron beam.

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